Regression: Telephone Input Price Growth - NERA Data

	Telephone Input Price Change (1)	US Input Price Change (2)	Divestiture	Moody's Yield Public Utility Bonds
1960	2.4%	1.7%	0	4.41%
1961	4.0%	2.9%	0	4.35%
1962	3.1%	4.5%	0	4.33%
1963	4.9%	3.9%	0	4.26%
1964	2.4%	5.4%	0	4.40%
1965	2.4%	4.4%	0	4.49%
1966	1.5%	5.5%	0	5.13%
1967	5.0%	2.8%	0	5.51%
1968	6.1%	6.4%	0	6.18%
1969	2.7%	4.0%	0	7.03%
1970	4.0%	3.2%	0	8.04%
1971	6.5%	6.6%	0	7.39%
1972	7.6%	6.0%	0	7.21%
1973	6.6%	6.6%	0	7.44%
1974	4.8%	4.2%	0	8.57%
1975	9.3%	8.5%	0	8.83%
1976	9.2%	9.2%	0	8.43%
1977	4.8%	7.3%	0	8.02%
1978	7.3%	7.0%	0	8.73%
1979	2.9%	7.7%	0	9.63%
1980	6.9%	7.0%	0	11.94%
1981	11.0%	9.5%	0	14.17%
1982	9.3%	3.1%	0	13.79%
1983	13.7%	6.2%	0	12.04%
1984	1.8%	6.5%	1	12.71%
1985	0.1%	4.0%	1	11.37%
1986	1.3%	3.8%	1	9.02%
1987	1.7%	3.2%	1	9.38%
1988	-3.2%	4.6%	1	9.71%
1989	-3.7%	4.2%	1	9.26%
1990	11.9%	4.3%	1	9.32%
1991	1.3%	2.9%	1	8.77%
1992	4.4%	5.1%	1	8.14%
Avg 60-84	5.6%	5.7%		
Avg 60-92	4.7%	5.3%		
Avg 85-92	1.7%	4.0%		

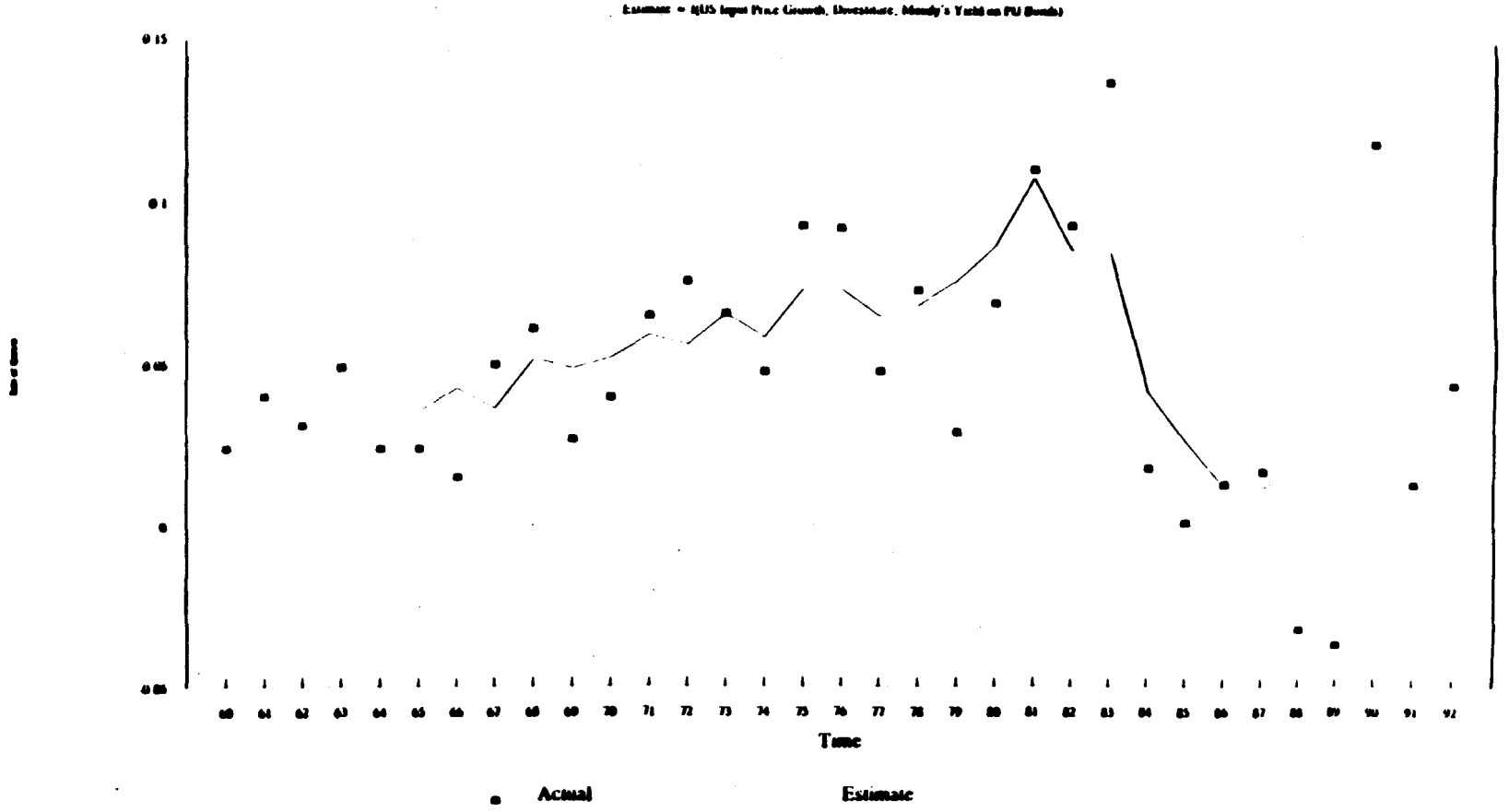
Regression Output:

Constant			-0.0046
Std Err of Y Est			0.0308
R Squared			0.4440
No. of Observations			33
Degrees of Freedom			29
	US IPr	Divestiture	Moody
X Coefficient(s)	0.3140	-0.0480	0.5794
Std Err of Coef.	0.3179	0.0144	0.2350
T-Statistic	0.9878	-3.3365	2.4653

F-Statistic
3. 29 7.7208

Sources: NERA US Input Prices (1960-1992), USTA Ex Parte 1/13/95
NERA Telecom Input Prices 1960 -1984, USTA Ex Parte 1/13/95
LEC Input Price Growth, 1993 Data Point TPP Update 1985-1992, USTA Ex Parte 2/1/95

Telephone Input Price Growth



Source: NERA US Input Prices (1960-1992), USTA Ex Parte, January 13, 1996
NERA Telecom Input Prices (1960-1994), USTA Ex Parte, January 13, 1996
LEC Input Price Growth, 1983 Data Point TFP Update (1986-1992), USTA Ex Parte February 1, 1996

Regression: Telephone Input Price Growth - Christensen Affidavit Data

Year	obs	TEL Input Price	US Input Price	Divestiture	Moody's Yield on PU Bonds
1948	1	3.2%	-1.0%	0	2.68%
1950	2	5.1%	6.3%	0	2.62%
1951	3	8.8%	7.9%	0	2.86%
1952	4	8.6%	1.2%	0	2.96%
1953	5	2.4%	3.7%	0	3.20%
1954	6	1.9%	0.6%	0	2.90%
1955	7	5.4%	6.6%	0	3.06%
1956	8	1.7%	0.7%	0	3.36%
1957	9	-1.1%	3.7%	0	3.89%
1958	10	3.3%	0.5%	0	3.79%
1959	11	5.4%	7.0%	0	4.38%
1960	12	4.2%	-0.6%	0	4.41%
1961	13	3.9%	3.6%	0	4.35%
1962	14	2.2%	4.4%	0	4.33%
1963	15	1.0%	3.8%	0	4.26%
1964	16	6.0%	4.5%	0	4.40%
1965	17	0.9%	5.7%	0	4.49%
1966	18	1.1%	4.6%	0	5.13%
1967	19	1.9%	2.0%	0	5.51%
1968	20	4.2%	4.4%	0	6.18%
1969	21	2.1%	3.7%	0	7.03%
1970	22	3.8%	3.3%	0	8.04%
1971	23	4.2%	6.8%	0	7.39%
1972	24	8.0%	7.2%	0	7.21%
1973	25	0.6%	6.3%	0	7.44%
1974	26	5.9%	4.2%	0	8.57%
1975	27	14.2%	9.4%	0	8.83%
1976	28	10.7%	9.1%	0	8.43%
1977	29	8.1%	8.6%	0	8.02%
1978	30	7.6%	7.8%	0	8.73%
1979	31	7.2%	8.2%	0	9.63%
1980	32	14.6%	6.6%	0	11.94%
1981	33	11.6%	9.9%	0	14.17%
1982	34	12.1%	3.7%	0	13.79%
1983	35	12.8%	5.6%	0	12.04%
1984	36	1.8%	7.4%	1	12.71%
1985	37	0.1%	4.0%	1	11.37%
1986	38	1.3%	3.8%	1	9.02%
1987	39	1.7%	3.1%	1	9.38%
1988	40	-3.2%	4.4%	1	9.71%
1989	41	-3.7%	4.1%	1	9.26%
1990	42	11.9%	4.2%	1	9.32%
1991	43	1.3%	2.9%	1	8.77%
1992	44	4.4%	5.1%	1	8.14%
1993					
Avg 48-92		4.7%	4.8%		
Avg 48-84		5.4%	4.9%		
Avg 84-92		1.7%	4.9%		

Regression Output:

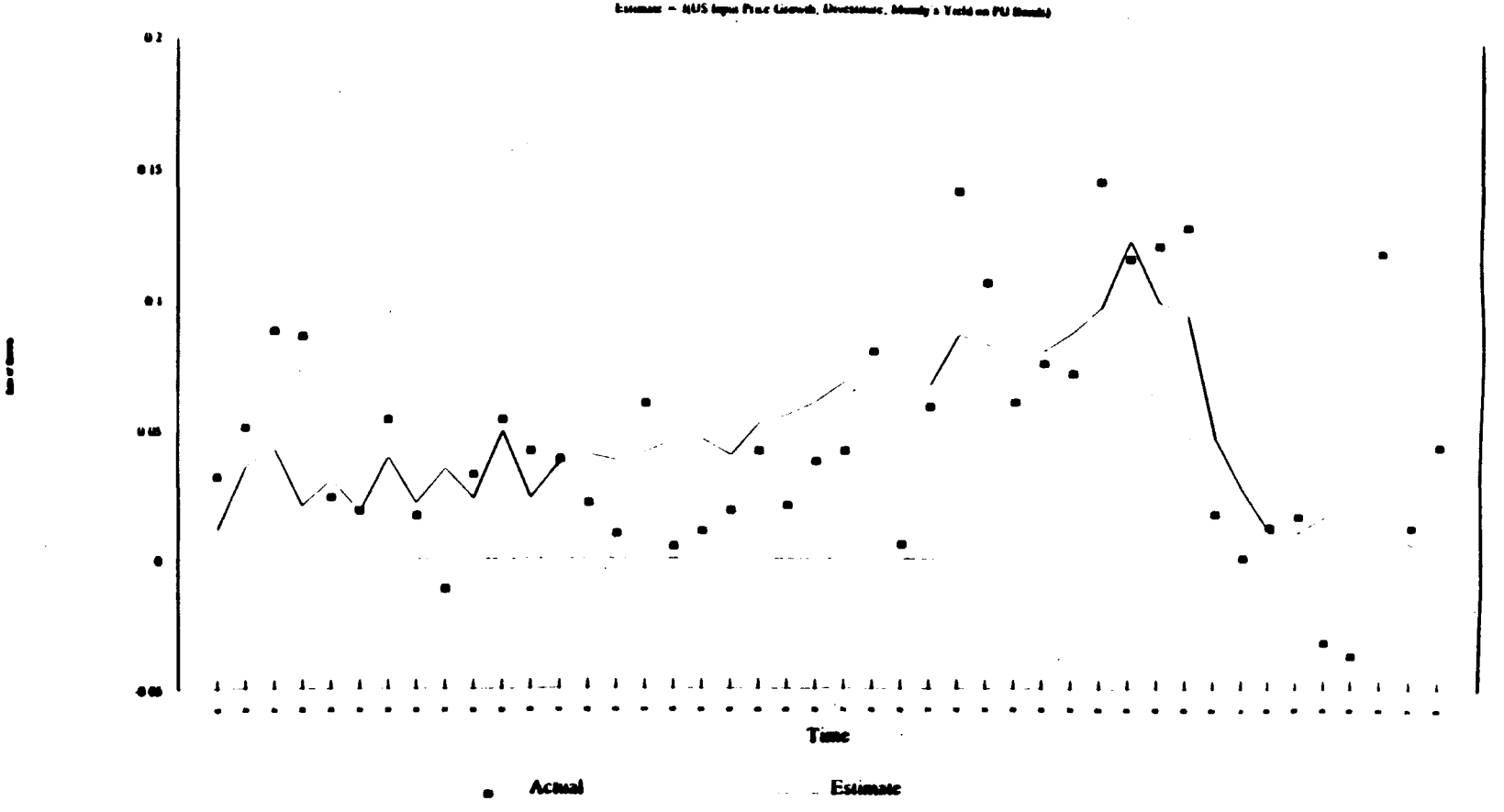
Constant	-0.0027
Std Err of Y Est	0.0347
R Squared	0.4322
No. of Observations	44
Degrees of Freedom	40

	US IPr G	Divestiture	Moody's
X Coefficient(s)	0.3402	-0.0579	0.6489
Std Err of Coef.	0.2338	0.0152	0.2093
T-Statistic	1.4553	-3.8142	3.1007

F-Statistic 10.1512
df (3,40)

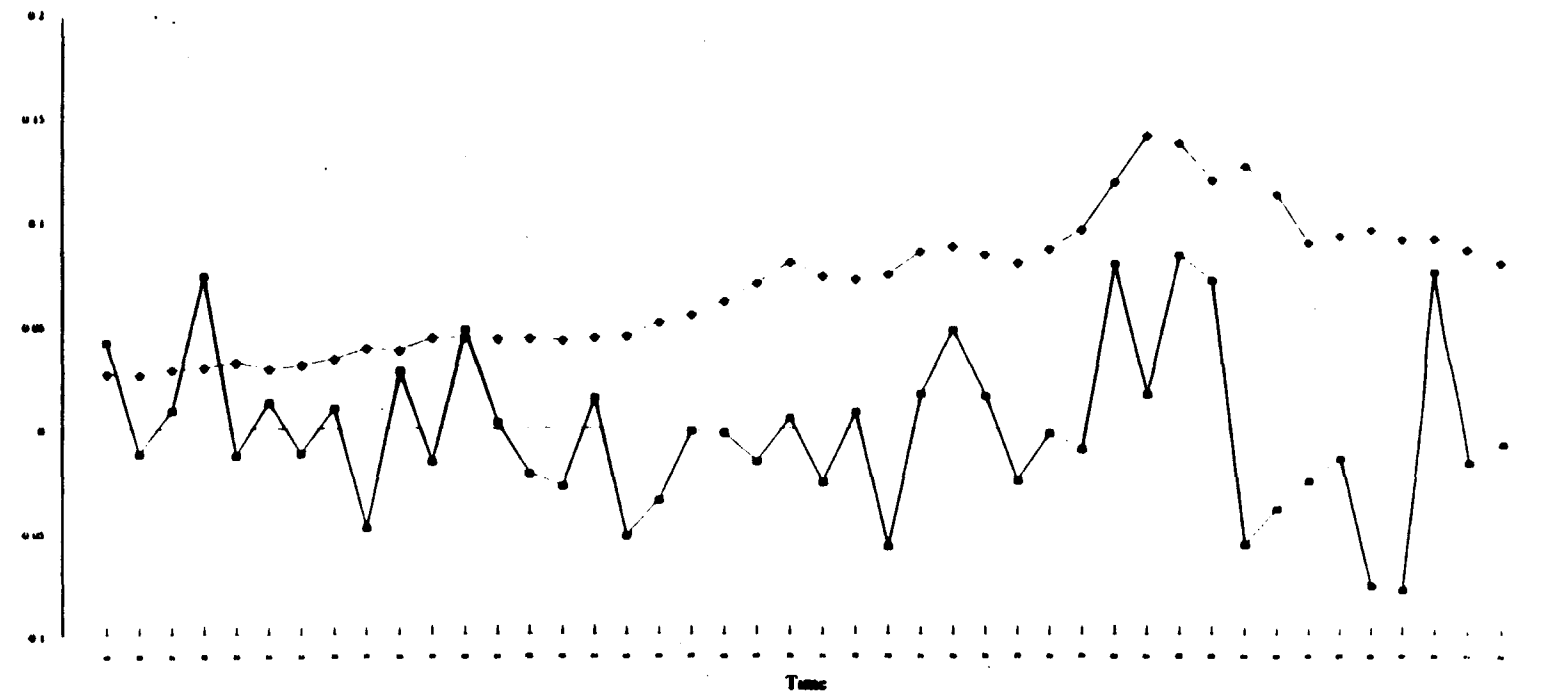
Sources: USTA Ex Parte, February 1, 1995, Christensen Affidavit

Telephone Input Price Growth



Data: USTA Ex Parte, February 1, 1996, Christensen Affidavit

Input Price Differential & Moody' Yield on PU Bonds



Source: [illegible]
[illegible]

Regression: Input Price Differential (NERA Data)

	LEC-US Input Price Growth	Divestiture	Moody's Yield Public Utility Bonds
1960	0.70%	0	4.41%
1961	1.10%	0	4.35%
1962	-1.40%	0	4.33%
1963	1.00%	0	4.26%
1964	-3.00%	0	4.40%
1965	-2.00%	0	4.49%
1966	-4.00%	0	5.13%
1967	2.20%	0	5.51%
1968	-0.30%	0	6.18%
1969	-1.30%	0	7.03%
1970	0.80%	0	8.04%
1971	-0.10%	0	7.39%
1972	1.60%	0	7.21%
1973	-2.00%	0	7.44%
1974	0.60%	0	8.57%
1975	0.80%	0	8.83%
1976	0.00%	0	8.43%
1977	-2.50%	0	8.02%
1978	0.30%	0	8.73%
1979	-4.80%	0	9.63%
1980	-0.10%	0	11.94%
1981	1.50%	0	14.17%
1982	6.20%	0	13.79%
1983	7.50%	0	12.04%
1984	-4.70%	1	12.71%
1985	-3.90%	1	11.37%
1986	-2.50%	1	9.02%
1987	-1.50%	1	9.38%
1988	-7.80%	1	9.71%
1989	-7.90%	1	9.26%
1990	7.60%	1	9.32%
1991	-1.60%	1	8.77%
1992	-0.70%	1	8.14%
Avg 60-84	-0.1%		
Avg 60-92	-0.8%		
Avg 85-92	-2.3%		

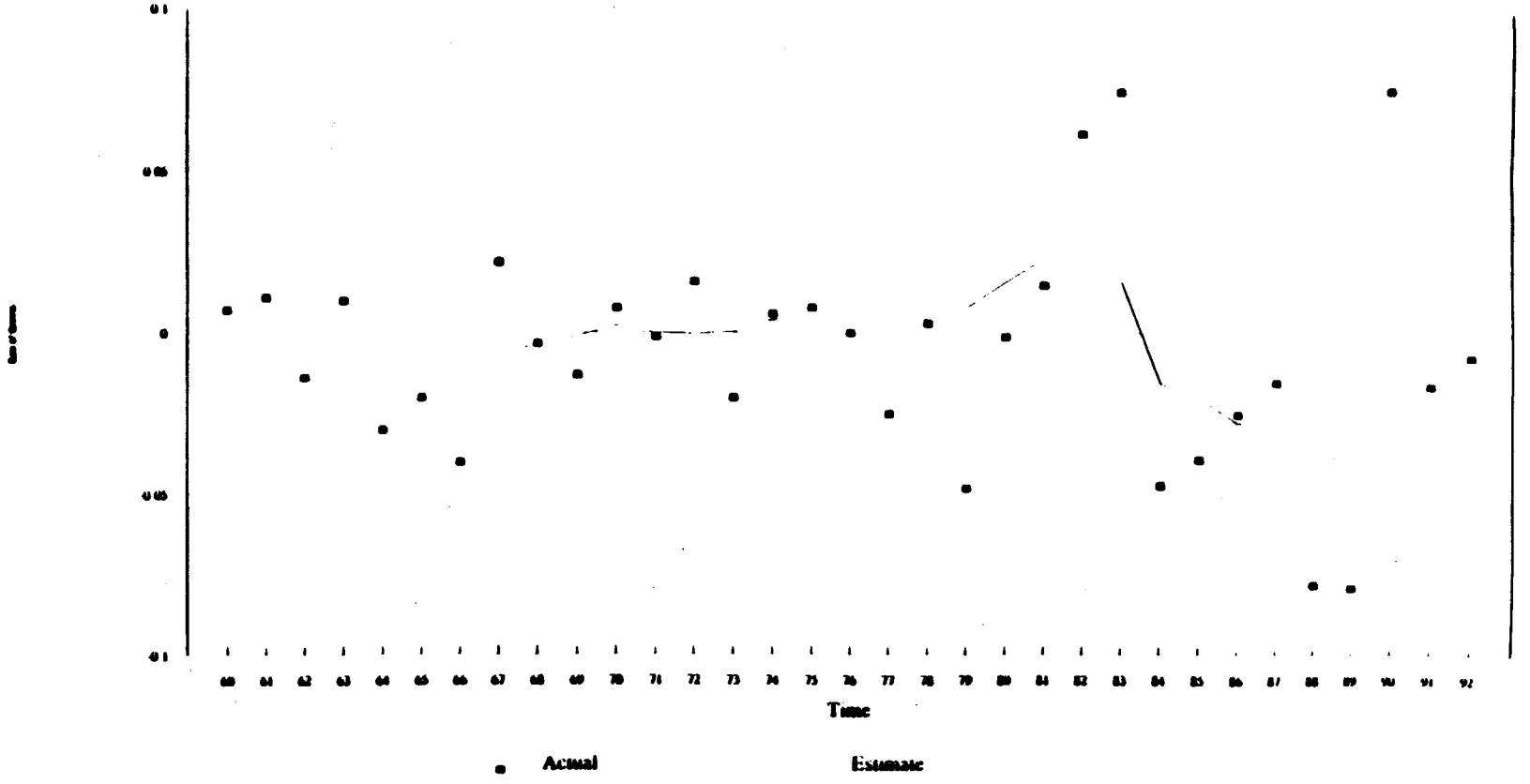
Regression Output:

Constant			-0.0251
Std Err of Y Est			0.0327
R Squared			0.1848
No. of Observations			33
Degrees of Freedom			30
		Divestiture	Moody
X Coefficient(s)		-0.0338	0.3419
Std Err of Coef.		0.0135	0.2200
t-statistic		-2.4935	1.5543
F-statistic	3.4001		
df(2,30)			

Sources: NERA US Input Prices (1960-1992), USTA Ex Parte, January 13, 1995
NERA Telecom Input Prices 1960 -1984, USTA Ex Parte, January 13, 1995
LEC Input Price Growth, 1993 Data Point TFP Update 1985-1992, USTA Ex Parte, February 1, 1995

Input Price Differential

Estimate = f(Divestiture, Moody's Yield on PU Bonds)



Sources: NERA US Input Prices (1960-1992), USTA Ex Parte, January 13, 1995
NERA Telecom Input Prices (1960-1994), USTA Ex Parte, January 13, 1995
LEC Input Price Growth (1986-1992), 1993 Data Point Update, USTA Ex Parte, February 1, 1995

Regression: Input Price Differential (Christensen Affidavit)

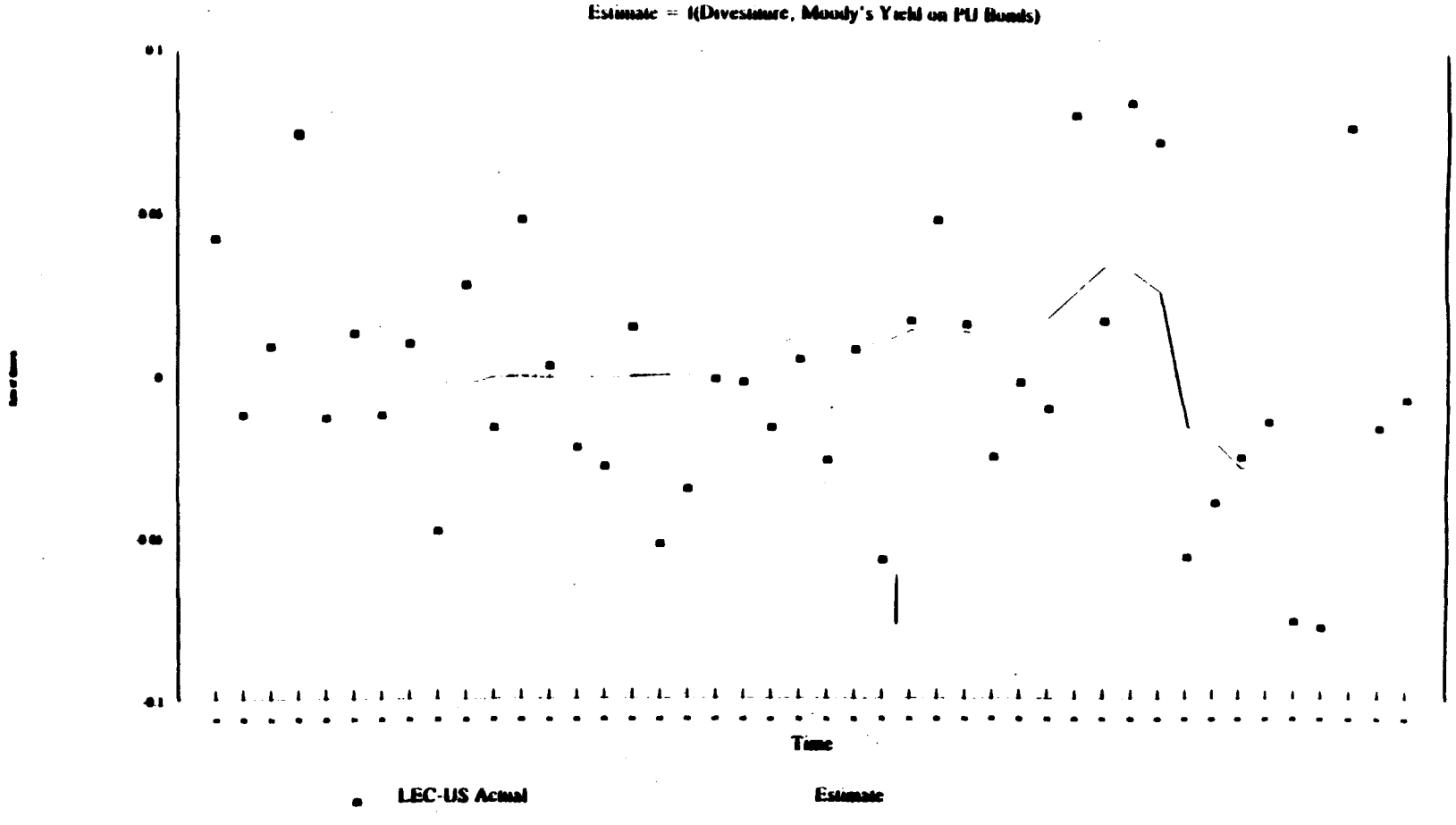
Year	obs	LEC-US Input Price Growth	Divestiture	Moody's Yield on Public U Bonds
1949	1	4.20%	0	2.66%
1950	2	-1.20%	0	2.62%
1951	3	0.90%	0	2.86%
1952	4	7.40%	0	2.96%
1953	5	-1.30%	0	3.20%
1954	6	1.30%	0	2.90%
1955	7	-1.20%	0	3.06%
1956	8	1.00%	0	3.36%
1957	9	-4.80%	0	3.89%
1958	10	2.80%	0	3.79%
1959	11	-1.60%	0	4.38%
1960	12	4.80%	0	4.41%
1961	13	0.30%	0	4.35%
1962	14	-2.20%	0	4.33%
1963	15	-2.80%	0	4.26%
1964	16	1.50%	0	4.40%
1965	17	-5.20%	0	4.49%
1966	18	-3.50%	0	5.13%
1967	19	-0.10%	0	5.51%
1968	20	-0.20%	0	6.18%
1969	21	-1.60%	0	7.03%
1970	22	0.50%	0	8.04%
1971	23	-2.60%	0	7.39%
1972	24	0.80%	0	7.21%
1973	25	-5.70%	0	7.44%
1974	26	1.70%	0	8.57%
1975	27	4.80%	0	8.83%
1976	28	1.60%	0	8.43%
1977	29	-2.50%	0	8.02%
1978	30	-0.20%	0	8.73%
1979	31	-1.00%	0	9.63%
1980	32	8.00%	0	11.94%
1981	33	1.70%	0	14.17%
1982	34	8.40%	0	13.79%
1983	35	7.20%	0	12.04%
1984	36	-5.60%	1	12.71%
1985	37	-3.90%	1	11.37%
1986	38	-2.50%	1	9.02%
1987	39	-1.40%	1	9.38%
1988	40	-7.60%	1	9.71%
1989	41	-7.80%	1	9.26%
1990	42	7.70%	1	9.32%
1991	43	-1.80%	1	8.77%
1992	44	-0.70%	1	8.14%
Avg 49-92		-0.08%		
Avg 49-84		0.4%		
Avg 84-92		-2.6%		

Regression Output:

		Divestiture	Moody
Constant			-0.0157
Std Err of Y Est			0.0375
R Squared			0.1702
No. of Observations			44
Degrees of Freedom			41
X Coefficient(s)		-0.0440	0.3464
Std Err of Coef.		0.0155	0.1944
t-statistic		-2.8330	1.7818
F-statistic	4.2036		
df (2,41)			

Source: USTA Ex Parte, February 1, 1995, Christensen Affidavit

Input Price Differential (Christensen Affidavit)



Source: USTA Ex Parte, February 1, 1988, Christensen Affidavit.

Appendix 3

AN EMPIRICAL ESTIMATE OF THE LEC PRICE CAP "X FACTOR" BASED UPON HISTORIC NATIONAL LEC PRODUCTIVITY AND INPUT PRICE TRENDS

FCC PRICE CAP PERFORMANCE REVIEW FOR LOCAL EXCHANGE CARRIERS

CC Docket 94-1

Dr. David J. Roddy
Dr. Lee L. Selwyn

prepared for the

Ad Hoc Telecommunications Users Committee

June, 1994

ECONOMICS AND TECHNOLOGY, INC.

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AN EMPIRICAL ESTIMATE OF THE LEC PRICE CAP "X FACTOR" BASED UPON HISTORIC NATIONAL LEC PRODUCTIVITY AND INPUT PRICE TRENDS

David J. Roddy
Lee L. Selwyn*

Introduction and Summary

Since January, 1991, all of the major Local Exchange Carriers (LECs) in the United States have been subject to a system of "price cap" regulation for their interstate telecommunications services that was adopted by the Federal Communications Commission (FCC) in October, 1990.[1] A central feature of the FCC's price cap program is a price adjustment mechanism that is based upon the general formula:

$$\text{Allowed change in PCI} = \text{GDP-PI} - X \pm Z$$

where PCI is the price cap index, GDP-PI is the fixed weight Gross Domestic Product Price Index, X is a numeric value determined by the Commission as an "offset" to the general inflation index, and Z is an adjustment for so-called "exogenous" cost changes affecting LECs and not otherwise captured in the price adjustment formula.[2] For the first four years of the LEC Price Cap program, the FCC set the X factor at 3.3%.[3] In the Commission's current LEC Price Cap review,[4] the calculation of the correct X factor for the next four years is

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*. The authors are, respectively, Vice President-Senior Economist and President, Economics and Technology, Inc., One Washington Mall, Boston, Massachusetts 02108.

1. *Policy and Rules Concerning Rates for Dominant Carriers*, FCC CC Docket 87-313, Second Report and Order, Released October 4, 1990.

2. *Id.* at 5-20. Note that the original ruling adopted the Gross *National* Product Price Index (GNP-PI). Since the US Department of Commerce is phasing out the GNP-PI in favor of the GDP-PI, we assume that the Commission will convert to the GDP-PI in the present proceeding. We will use the GDP-PI exclusively in this study; the practical differences between the two indices are not consequential.

3. Alternatively, a LEC may elect to use a 4.3% X factor in return for a more favorable "sharing" formula which permits the LEC to retain a greater portion of its excess earnings.

4. *In the Matter of Price Cap Performance Review For Local Exchange Carriers*, NPRM, FCC CC Docket 94-1, Released February 16, 1994.

likely to be the most important economic issue to be addressed. On the one hand, the United States Telephone Association (USTA) has commissioned a study of LEC productivity (the "Christensen Study") and has interpreted its results as supporting an X factor of 1.7%.[5] Other parties, including the Ad Hoc Committee, have argued that a much higher X factor is required in order to prevent excessive prices and earnings and to fulfill the goals of price cap regulation. For example, an AT&T study shows that the X factor should be 5.47%, while a study offered by MCI supports an X factor of 5.9%.[6] In its initial Comments, the Ad Hoc Committee did not propose a specific quantity for the X factor because it did not have at that time certain data that is required for such a calculation. That data has now been provided by USTA and an X factor calculation is now possible. In this analysis, we develop a quantitative estimate for the appropriate X factor using the new data provided by USTA in both the Christensen Study as well as in the Christensen Supplementary Data.[7] Overall, the conclusions of this study[8] are:

- The correct calculation of the X factor includes the historic post-divestiture LEC productivity growth rate, adjusted to recognize the decreasing *real price* of LEC inputs, *plus* the appropriate "consumer dividend."

- Based upon Dr. Christensen's *complete* results, the bare minimum value for a national LEC X factor would be a 2.6% productivity growth *plus* a 2.6% input price differential *plus* a consumer dividend. The consumer dividend would be 0.5% if the LEC elects to begin sharing at 100 basis points over the authorized rate of return or 1.5% if the LEC elects to begin sharing at 200 basis points over the authorized rate of return. Thus, the correct X factor for the FCC's LEC price cap system is not less than 5.7% with sharing at 100 basis points or 6.7% with sharing at 200 basis points.

- Any value for the X factor below the 5.7% (or 6.7%) level would constitute a direct transfer of wealth from ratepayers to LECs. This could amount to a LEC windfall revenue gain of approximately $800-million each year of the plan. Over a five-year

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5. L. Christensen, P. Schoech, and M. Meitzen, "Productivity of the Local Operating Telephone Companies Subject to Price Cap Regulation," Christensen Associates, submitted as Attachment 6 to the *Comments of the United States Telephone Association*, FCC CC Docket 94-1, May 9, 1994 at 12. ("Christensen Study").

6. *Comments of AT&T*, FCC CC Docket 94-1, May 9, 1994, at 22; and *Comments of MCI*, FCC CC Docket 94-1, May 9, 1994, at 18.

7. Some of the underlying data for the Christensen Study was not included in the original May 1994 Filing. It was subsequently provided in the *Response of the United States Telephone Association to Ad Hoc's Motion to Compel and Motion for Extension of Time*, June 2, 1994 ("Christensen Supplementary Data").

8. *See also*, Economics and Technology, Inc., "LEC Price Cap Regulation: Fixing the Problems and Fulfilling the Promise," ("ETI Report") attached to the *Comments of the Ad Hoc Telecommunications Users Committee*, FCC CC Docket 94-1, May 9, 1994.

period, the cumulative loss to LEC ratepayers could exceed $12-billion for LEC interstate services at the national level.

- Our 5.7% X factor estimate is in the same range as other studies by AT&T (at 5.47%) and MCI (at 5.9%). The fact that all three studies use different methods and data sources and yet obtain similar results confirms the reasonableness of our estimate.

This study is organized into six sections. First, we explain how companies in competitive industries ("competitive companies") flow through changes in their productivity to consumers. Second, we detail how competitive companies flow through changes in the prices that they pay for their inputs. Third, we summarize and explain the Christensen Study's 2.6% per year productivity result. Fourth, we highlight and explain the Christensen Study's 1.1% input price result — which is 2.6 percentage points lower than the GDP-PI rate of 3.7%. The fifth section shows how the data clearly rejects the incorrect assumption regarding input price growth that was used in the development of the LECs' proposed X factor. In the final section, we combine the input price differential and the productivity rate to obtain a 5.2% productivity adjustment. Addition of the Commission's 0.5% consumer productivity dividend yields this study's estimate of the correct X factor of 5.7% for the next four years. A technical appendix presents a formal analysis of the incorrect USTA assumption regarding input price growth.

I. Competitive companies cannot indefinitely retain gains from increased productivity; as others adopt similar improvements, the reduced costs are flowed through to consumers.

In competitive industries,[9] price levels are set by the marketplace and are heavily influenced by (a) the level of input prices confronted by individual firms, (b) the technology and production methods available to each incumbent, and (c) demand and supply conditions overall. Individual firms have incentives to reduce their costs and to improve their efficiency because by so doing they can generate greater profits either by (a) increasing unit profit at prevailing market (output) price levels, and/or (b) by setting prices below those charged by competitors and thereby expanding sales and market share. These gains are by no means permanent. In time, the new production techniques and even the new technologies and inventions are mimicked by rivals, and so a competitive firm's market share and profit gains will

9. A "competitive industry" is one in which no single firm can have a significant influence upon overall market price levels and in which the various producers' products or services are sufficiently close substitutes to one another that only relatively small price differences will be sustainable. The theoretical "perfectly competitive" market is the limiting case, but markets that fall far short of this theoretical model are able to function quite competitively. The "competitive result" goal of economic regulation requires results comparable to "effective competition," not "perfect competition."

typically be short-lived.[10] Even where protected by a patent, firms may often find it necessary to broadly license new technology in order to establish it in the marketplace.[11] Thus, there is no expectation in a competitive market that an efficiency gain on the part of an individual firm will create a *permanent* increase in profits.

Table 1

Productivity Changes in a Competitive Company

Year	Number of Widgets "Output"	Number of Person Hours "Input"
1991	20,000	3,000
1992	20,000	2,800
1993	20,000	2,800

In short, in competitive industries the price adjustment mechanism is subject to *constant review* by the marketplace itself; output price levels are affected by a variety of processes that work to limit the actions of individual producers and the duration of gains that may result from actions that an individual firm may be able to initiate. This condition can be illustrated through a somewhat simplified example, which is summarized in Table 1. This example demonstrates the standard economic effect that competitive companies flow through productivity changes by lowering the price that the firm charges its customers.

Consider the case of a single-product manufacturing company, operating under competitive market conditions, that makes "widgets" using labor and raw materials as its basic inputs. In 1991, it took 3,000 hours to produce 20,000 widgets; in the next year — due to improvements in the company's production techniques — it only took 2,800 hours to produce the same quantity of widgets. In this instance, the productivity gain results from changes in the *quantity* of labor input used to produce the output (widgets) that the company sells. The company also uses raw materials in its operations. However, since the quantity and price of materials used did not change in either year, we can omit materials from the illustrative analysis without affecting the results of our example. In the third year, 1993, no additional productivity gains occur and the manufacturer again produces 20,000 widgets with 2,800 labor hours.

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10. One need look no further than the personal computer industry for a case study of this phenomenon. IBM, whose own antitrust case was settled with the government on the *very same day* that the break-up of the Bell System was announced (January 8, 1982), introduced the PC and established its platform as the *de facto* industry standard, yet suffered a precipitous loss of market share and profits as numerous rivals, large and small, quickly replicated the IBM PC and literally flooded the market with clones.

11. This is particularly the case where the underlying product or service is characterized by significant externalities in either demand or supply, as is often the case with telecommunications and information technology. Examples include personal computer hardware and software "platforms," videocassette formats, facsimile machine communications standards and protocols, modems, and data storage and transmission media.

Table 2 shows how the change in the *quantity of labor* that is required to produce the widgets is reflected in the basic product price. In 1991, the manufacturer had to charge $1.50 per unit for its product.[12] In 1992, the manufacturer experienced the productivity gain that lowered its cost to $1.40, but was able to retain the $1.50 price level for the moment because as of that date none of its rivals had adopted the new techniques. However, by 1993, a sufficient number of other firms had achieved the same productivity increase so that the prevailing market price was bid down to $1.40; firms that had not adopted the new methods (and hence did not experience the cost reduction) will also be forced to lower their prices, and either accept the loss of profits or exit the market. The $0.10 change in market price *that is due solely to the change in the quantity of labor* that was required to produce the widgets is ultimately flowed through to consumers because the manufacturer's rivals also experienced the same productivity changes, albeit with a one-year lag. Since this manufacturer has no permanent advantage or special market power vis-a-vis its rivals, its output price is set by the marketplace and will necessarily respond to industry-wide productivity changes. In this way, the changes in productivity are passed on to consumers in the output price of the product.

Table 2

Productivity Flow-through in a Competitive Company

(20,000 units of output)

Year	Wage Rate Per Hour	Total Labor Cost	Unit Product Cost	Unit Price
1991	$10	$30,000	$1.50	$1.50
1992*	$10	$28,000	$1.40	$1.50
1993	$10	$28,000	$1.40	$1.40

* Unit price for 1992 assumes that productivity gain is not mimicked by other firms until 1993.

II. Competitive companies also flow through industry-wide changes in the cost of inputs.

Suppose that, in addition to the productivity changes discussed above, a decline in the cost of labor (the wage rate per hour) also occurred between 1991 and 1992. Unlike the previous example, where only one firm initially realized the productivity gain, the lower labor price will be available to *all incumbents, and at the same time*. Table 3 shows how the change in the *price of labor* from $10 per hour in 1991 to $8 per hour in 1992 would be reflected in the widget's basic product price. Again, we assume that the technical productivity advancement would be enjoyed in 1992 by only the one firm that first adopted it, but that by the following

12. We also do not include a separate discussion of competitive profits that the manufacturer makes; while it can be assumed that firms operating in competitive industries generally do earn some profit, discussion of the baseline level of profit is not necessary to the present examination of the effects of productivity changes upon the firm's output price. We do observe, however, that in the first year in which our sample firm introduces its new production techniques (a year ahead of its rivals), it can generate a *temporary* increase in profit to the extent that it can retain its pre-improvement price level. However, that gain is short-lived, and will disappear as soon as others adopt the same improvement (see Table 2).

year competing companies would adopt the new techniques, and that all firms would be forced to flow through the savings in their output prices. The input price decrease (the $2 drop in the hourly wage), however, would necessarily be flowed through by all firms as soon as it is realized.

It is importance to emphasize the point that there are two separate effects occurring simultaneously in this case. First, the quantity of labor required decreased from 3,000 to 2,800 hours. This is the *productivity effect*. Second, the price of labor declined from $10 to $8 per hour. This is the *input price effect*. They are distinct components and they may occur individually or in combination. The example in Table 3 combines both effects simultaneously.

Table 3

Input Price Flow-through in a Competitive Company

(20,000 units of output)

Year	Wage Rate Per Hour	Total Labor Cost	Unit Product Cost	Unit Price
1991	$10	$30,000	$1.50	$1.50
1992*	$ 8	$22,400	$1.12	$1.20
1993	$ 8	$22,400	$1.12	$1.12

* Unit price for 1992 assumes that productivity gain is not mimicked by other firms until 1993.

As shown in Table 3, in 1991 the manufacturer charged $1.50 as the output price. In 1992, all of the firms experienced a 20% drop in the labor cost, so the market price of widgets falls to $1.20. In 1993, the productivity gain realized in 1992 by the innovative firm was captured by others, thereby reducing the market price of widgets to $1.12. Again, the change in price due to *both* the productivity effect and the input price effect is automatically flowed through to consumers because all of the other firms also experience the same productivity and input price changes. Thus, in addition to our earlier result concerning productivity, it is clear that competitive companies must also flow through input price changes to their customers. This combined productivity effect and input price effect is represented by the $0.38 decline in price from 1991 to 1993.

While productivity effects and input price effects operate in similar (but not in identical) ways in competitive markets, their respective impacts upon the price of the firm's product are separate and cumulative. Table 4 demonstrates that the input price decrease will be flowed through to consumers *even if no productivity gain were to occur*. In this example, the $10 per hour cost of labor in 1991 declines to $8 in 1992, as in the above example, *but there is no other change in productivity or cost*. As the table shows, the $2 per hour wage rate decrease results in a cost drop of 30 cents per unit of output which, because it is experienced by all firms in the industry, reduces the market price of widgets from $1.50 to $1.20.

In order to properly simulate competitive market conditions and thereby to assure a "competitive result," it is essential that the FCC's price cap regulation system correctly recognize and distinguish between the *productivity effects* and the *input price effects* that are experienced by and/or that confront LECs. In the price cap system, *input price changes* are

supposed to be captured through the use of an external inflation index, such as the GDP-PI, which is then "offset" to capture "standard" LEC productivity gains reflective of historical experience.[13] But the GDP-PI is not a measure of *input price changes*, it is in fact a measure of *output price changes*. USTA and the LECs agree that the GDP-PI must be converted into an input price index; their approach to doing this is, however, to ignore the conditions that firms in the telecommunications industry confront, and instead to focus upon economy-wide cost changes that bear little if any relationship to telecommunications. As we show below, USTA's own study provides compelling evidence — upon which its experts have themselves relied in developing their own LEC productivity estimates — that LEC input prices are growing far more slowly than input prices confronting the overall economy, that in effect the LECs are enjoying *decreases* in real terms (i.e., adjusted for inflation) in the cost of their inputs. As shown in our example, a price cap system which ignores this condition will not achieve a competitive result.

Table 4

Input Price Flow-through in a Competitive Company With No Productivity Change

(20,000 units of output)

Year	Wage Rate Per Hour	Total Labor Cost	Unit Product Cost	Unit Price
1991	$10	$30,000	$1.50	$1.50
1992*	$ 8	$24,000	$1.20	$1.20
1993	$ 8	$24,000	$1.20	$1.20

* For 1992, flow-through occurs immediately, since all firms confront the reduced labor wage rate at the same time.

III. LEC national productivity growth is at least 2.6% per year.

The Christensen Study calculates estimates of national LEC productivity over the time period from 1984 through 1992. The productivity results of that Study are summarized in Table 5. Input is measured as the *quantity* of capital, labor, and materials used to produce LEC telephone services. While the *intent* is to measure changes in *physical* quantities, in some cases monetary amounts ("constant dollar indexes") are used because there is no single physical measure that can capture the full range of inputs used by a LEC. The measure of capital — which includes buildings, central office equipment, computers, cable, vehicles, and similar items — grew at an annual rate of 3.5%.[14] The number of employees, denoted as labor, declined at an annual rate of 3.3%. Other resources used to produce telephone service,

13. Note that we specifically do not agree with the USTA procedure of subtracting US productivity gains from the LEC productivity rate to obtain a 'differential productivity' measurement. The reasons for our disagreement are detailed in this analysis.

14. Throughout this analysis, we use the same procedure (based on the difference in natural logarithms) to calculate growth rates as cited in the Christensen Study in his footnote 9 at 10.

("materials"), grew at a rate of 1.1%. These three items are combined into total input, which, in the aggregate, grew at an annual rate of 0.9%.[15] (This aggregate is a weighted average of the three components.) The measure of the telephone services provided to customers by the LECs — output — grew at an annual rate of 3.5%. Since the Total Factor Productivity ("TFP") growth rate is the output rate minus the input rate, LEC TFP, according to Dr. Christensen's calculations, grew at an annual rate of 2.6% over the post-divestiture time period. The quantity indexes for individual years for total input and total output are shown in Table 6. The Christensen Study methodology and data measurement procedures are in general accord with the recommendations set forth in the May 9 ETI Report as well as with typical academic and government studies.[16] However, despite the provision of some additional data by USTA (via the Christensen Supplementary Data), it is not possible to fully verify or audit all aspects of the calculations. We can conclude that the LEC productivity growth rate is no less than the 2.6% cited by Dr. Christensen. This productivity rate identifies and, in fact, guarantees substantial cost reductions in the production of LEC telecommunications services.

Table 5

National LEC Telecommunications Industry

Total Factor Productivity and Components

Average Annual Growth Rates 1984-1992

Input	Growth in Quantity
Capital	3.5%
Labor	-3.3%
Materials	1.1%
Total Input	0.9%
Total Output	3.5%
Productivity Growth Rate	2.6%

Sources: Christensen May 1994 Study and Christensen June 1994 Data.

Although the Christensen Study finds the rate of LEC productivity growth at 2.6%, that is distinctly not the value of the X factor that is being sought by USTA and its members. As we

15. This input quantity growth estimate is critically dependent upon Christensen's use of the 1.1% annual LEC input price growth rate as shown in Table 1 of the Christensen Supplementary Data. See the Technical Appendix, *infra.*, for a detailed discussion of this issue and its ramifications for the resulting TFP calculations.

16. See ETI Report at 60-65. An example of a Bureau of Labor Statistics government study is Duke, J., D. Litz, and L. Usher, "Multifactor Productivity in Railroad Transportation," ***Monthly Labor Review***, August 1992, at 49-58 and "Technical Note, Multifactor Productivity Index, Class I Railroads, SIC 4011."

demonstrate below, USTA has fundamentally misapplied the Christensen results in seeking to transform into an X factor that is consistent with its own price cap agenda.[17]

Table 6

National LEC Telecommunications Industry
Aggregate Output and Aggregate Input
Quantity Indexes

1984-1992

year	input quantity	output quantity
1984	1.000	1.000
1985	1.012	1.031
1986	1.015	1.062
1987	1.033	1.103
1988	1.065	1.160
1989	1.094	1.219
1990	1.086	1.266
1991	1.099	1.295
1992	1.078	1.322
annual rate	0.9%	3.5%

Sources: Christensen May 1994 Study and Christensen June 1994 Data.

17. The 2.6% historic productivity growth rate developed in the Christensen Study necessarily embraces a time period during which rate of return regulation, not price cap regulation, was in effect. Indeed, that is the case for seven out of the nine years (1984-90) included within the Christensen data base. Assuming that price cap regulation fulfills its promise and stimulates efficiency gains beyond those than would prevail under RORR, the productivity growth rate estimated by Christensen must understate that which would exist under a price cap regime. No adjustment has been made by USTA to account for this effect, but its presence does, at a minimum, provide a strong argument for retaining the Commission's Consumer Productivity Dividend (CPD) into the future.

IV. LEC input price growth is 2.6% per year less than growth in GDP-PI.

Although both Christensen and USTA make an unsupported *assumption* that LEC input prices rise at the rate of GDP-PI plus economywide productivity, the Christensen Study (in the Christensen Supplementary Data) clearly shows the *actual* pattern of LEC input price growth. These input price results of the Christensen Study are summarized in Table 7. Note that, as with the competitive widget manufacturer discussed earlier, we distinguish carefully between the *input price* changes of this section from the *input quantity* changes of the previous section. The input price analysis here corresponds to the discussion of the impacts of the wage rate reduction from $10 per hour to $8 per hour which we illustrated for the competitive widget manufacturing firm.

Table 7

National LEC Telecommunications Industry

Input Prices

Average Annual Growth Rates 1984-1992

Input	Growth in Price
Capital	-1.9%
Labor	3.7%
Materials	3.7%
Total LEC Input Price Growth Rate	1.1%
GDP Price Index	3.7%
Input Price Differential	2.6%

Sources: Christensen May 1994 Study and Christensen June 1994 Data.

Christensen's input price results show that the price of labor and the price of materials grew at an average annual rate of 3.7% for the post-divestiture time period. Reflecting very slow growth in the acquisition price of capital equipment and declines in interest rates overall, the price of capital (the "carrying cost" or "rental value") *declined* at an annual rate of 1.9% during the 1984-92 period. The aggregate input price, which is a weighted average of the three components, increased very slowly, at an annual rate of 1.1% per year.

In contrast to the very slow growth of LEC input prices, the Gross Domestic Product Price Index, the GDP-PI, grew at an annual rate of 3.7% during this time period.[18] Since LEC input prices grew at an annual rate of 1.1%, it is convenient to express LEC input price growth as *GDP-PI minus 2.6%*. The 2.6% can thus be referred to as the "input price differential," since it is the difference between the slow rate of growth of LEC input price growth and the much larger annual changes in GDP-PI. (It is important to note at this juncture that it

18. U. S. Department of Commerce, Bureau of Economic Analysis, *Survey of Current Business*, Volume 73, No. 9, September, 1993 at 53.

is purely a coincidence that the productivity rate and the input price differential both happen to take on the same value of 2.6%. This is not required. In all cases, the actual calculations, as illustrated above, determine the values.) The price indexes for individual years are shown in Table 8. The total input price column which rises from 1.000 in 1984 to 1.088 in 1992 shows clearly that input prices rose a mere 8.8% over the entire 8 year time period. This is the source of our annual rate result of 1.1% cited earlier. During that same period, GDP-PI rose by a total of 34%, or at an annual rate of 3.7%. The 2.6% figure is the arithmetic difference between 3.7% and 1.1%.

Put slightly differently, the *nominal* 1.1% annual increase in LEC input prices translates into an *annual decrease in the real price of LEC inputs* of approximately 2.6%. Recalling our earlier discussion of the competitive widget manufacturer, it is clear that if a LEC were to behave "competitively," it would flow through *both* the productivity gains discussed in the previous section *as well as* the decline in real (i.e., inflation-adjusted) input prices discussed in this section. It could not flow through any higher input prices than this because competition would not allow it.

While the Christensen Study has *determined* that LEC input prices grew at the 1.1% annual rate, USTA has *ignored* that particular finding in its *translation* of the Christensen results into a specific X factor proposal. Instead, USTA has *assumed* that LEC input prices grew at the same rate as input prices for the economy generally, which works out to a 4.6% input

Table 8

National LEC Telecommunications Industry
Input Price Indexes

1984-1992

year	input price per Christensen	input price assumed by USTA
1984	1.000	
1985	0.995	
1986	0.992	
1987	1.012	
1988	1.014	
1989	0.960	
1990	1.083	
1991	1.123	
1992	1.088	
Cumulative Change: 1984-1992	8.8%	45.0%
annual rate	1.1%	4.6%

Sources: Christensen May 1994 Study and Christensen June 1994 Data.

price growth rate.[19] In a competitive market, however, firms would be forced to flow through their actual input price changes, not the economy-wide results that may bear little, if any, direct relationship to a particular industry's own unique situation. Recalling the discussion of the wage rate decrease encountered by the competitive widget manufacturer in our earlier example, it is clear that in a competitive environment a LEC would not be able to flow through any input price changes higher than those which were actually being experienced by it and by similar firms in the same industry. This result would be forced by the discipline of the marketplace.[20]

In sharp contrast and despite specific data showing precisely the contrary, it is very clear that both of USTA's X factor experts, Dr. Christensen and Dr. Taylor, assume that LEC input prices rise at the same rate as economy-wide input prices in the development of USTA's currently proposed X factor.[21] In the face of evidence that LEC input prices actually grew by only 1.1% per year, this incorrect assumption should be discarded.[22] In fact the results shown in the Christensen Supplementary Data (summarized in Table 7 and 8 above) confirm that there is no possibility that the LEC assumption can be correct. Because there has been some confusion surrounding this issue, it is discussed in more detail in the next section.

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19. As discussed more fully in the May 9 ETI Report, *economy-wide* input prices are assumed to grow at the economy-wide output price inflation rate, GDP-PI, plus the economy-wide productivity growth rate, 0.9%. The reasoning here is that if output prices rise at 3.7% after capturing an overall 0.9% productivity gain, then it must follow, by deduction, that economy-wide input prices grew at a 4.6% annual rate. From the Christensen Study, however, we can determine (not assume) that *LEC input prices* are rising by only 1.1% each year. Hence, the unsupported USTA assumption of a 4.6% input price growth rate effectively overstates the rate of LEC cost change by 3.5% per year.

20. Also recall from Table 3 that a competitive firm would flow through *both* the slow input price growth (relative to economy-wide input price changes) as well as any productivity gains that it — or that its industry — was achieving. There is no double counting here: Real input price decreases would be flowed through even in the absence of productivity changes, and productivity gains would be flowed through even if input prices changes at the same rate as that for the economy as a whole. If both conditions happen to be occurring, as they are in the case of LECs, then both effects would be flowed through to consumers by competitive firms.

21. See, e.g., W. Taylor, "Economic Performance of the LEC Price Cap Plan," submitted as Attachment 5 to the *Comments of the United States Telephone Association*, FCC CC Docket 94-1, May 9, 1994 at 8-11 (and particularly footnote 9 therein) and Christensen Study at ii and 12. Also see the statements of Christensen and Taylor submitted in the initial price caps dockets which originated the formula: L. Christensen, "The Role of Inflation and Productivity Measures in Price Cap Regulation," Appendix F to *Comments of AT&T in Response to FCC NPRM in CC Docket 87-313*, October 19, 1987, at 9-11 and W. Taylor, "Productivity Offsets for LEC Interstate Access," Attachment A to the *Reply Comments of USTA in CC Docket 87-313*, June 8, 1990.

22. In fact, this incorrect LEC assumption — that LEC input prices are rising by 4.6% (i.e., by GDP-PI *plus* 0.9) — is the reason why Christensen and USTA subtract 0.9% from the 2.6% productivity rate to arrive at their 1.7% proposed X factor.

It should by now be apparent that the conclusion of this section — that LEC input prices grew at a rate of 1.1% per year over the post-divestiture time period — is clearly proven by USTA's own data. Since the GDP-PI grew at a rate of 3.7% per year, LEC input prices can be represented as GDP-PI *minus* 2.6%. The productivity rate of 2.6% *plus* the input price differential of 2.6% *plus* the consumer dividend of 0.5% establishes 5.7% *as the bare minimum value for the X factor in the price cap formula.* Anything below that amount will permit price cap LECs to acquire windfall gains in earnings and thereby to pursue a variety of pricing, cross-subsidization, and anticompetitive practices that this form of regulation was expressly intended to prevent.

V. Adoption of the incorrect USTA assumption regarding LEC input price changes will result in excessive annual LEC rate increases over the full term of the price cap plan.

As noted earlier, the current LEC Price Cap Program is premised upon a measure of US economy-wide inflation (represented by GDP-PI) *minus* a "productivity offset" factor of 3.3%. The GDP-PI is an index of *output prices*, which are not necessarily the same as the *input prices* actually paid by LECs for the specific labor, materials and capital equipment which they employ in producing their services. It is generally accepted that economy-wide input prices have been increasing at the rate of 3.7% *plus* 0.9% (the economy-wide productivity growth rate) over the post-divestiture time period. For the aggregate US economy, this equals a total input price growth rate of 4.6%.[23] Thus, since USTA assumes that LEC input prices rise at the rate of economy-wide input prices, USTA claims an input price growth rate even greater than the GDP-PI rate of 3.7%.

In formulating the X factor in the initial LEC Price Caps Order, the Commission did not specifically analyze the trends in LEC input prices relative to the GDP-PI. Instead, the calculation relied upon this critical *assumption* that LEC input prices rise faster than the GDP-PI, i.e., at the rate of economy-wide input prices. This assumption resulted in the "differential" productivity offset concept, which subtracts out national economy productivity from the actual LEC productivity to calculate the productivity offset.[24]

Given the Christensen Supplementary Data, however, this LEC *assumption*, which is embedded in the FCC's 3.3% offset, can now be evaluated using actual LEC historic data. The results detailed above show that the implicit LEC (and FCC) assumption regarding LEC input price trends is false. In fact, rather than rising faster than GDP-PI, the Christensen

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23. The general formula for the growth rate of economy-wide input price is GDP-PI *plus* the US productivity growth rate.

24. FCC, *Policy and Rules Concerning Rates for Dominant Carriers*, CC Docket NO. 87-313, *Second Report and Order*, FCC 90-314 released October 4, 1990 at para. 74. A complete mathematical derivation is provided in the analysis of this issue in the Technical Appendix.

input price data confirms that LEC input prices have increased at an average of 2.6 percentage points *more slowly* than the GDP-PI. Put another way, the USTA assumes that LEC input prices increased a total of some 45.0% over the 1984-1992 time frame. This assumption, however, is dramatically rejected by the Christensen Supplementary Data which shows specifically that LEC 'Total Input Price' actually increased a mere 8.8% over this period.[25] Figure 1 clearly shows the incorrect assumption, in contrast to the actual data.

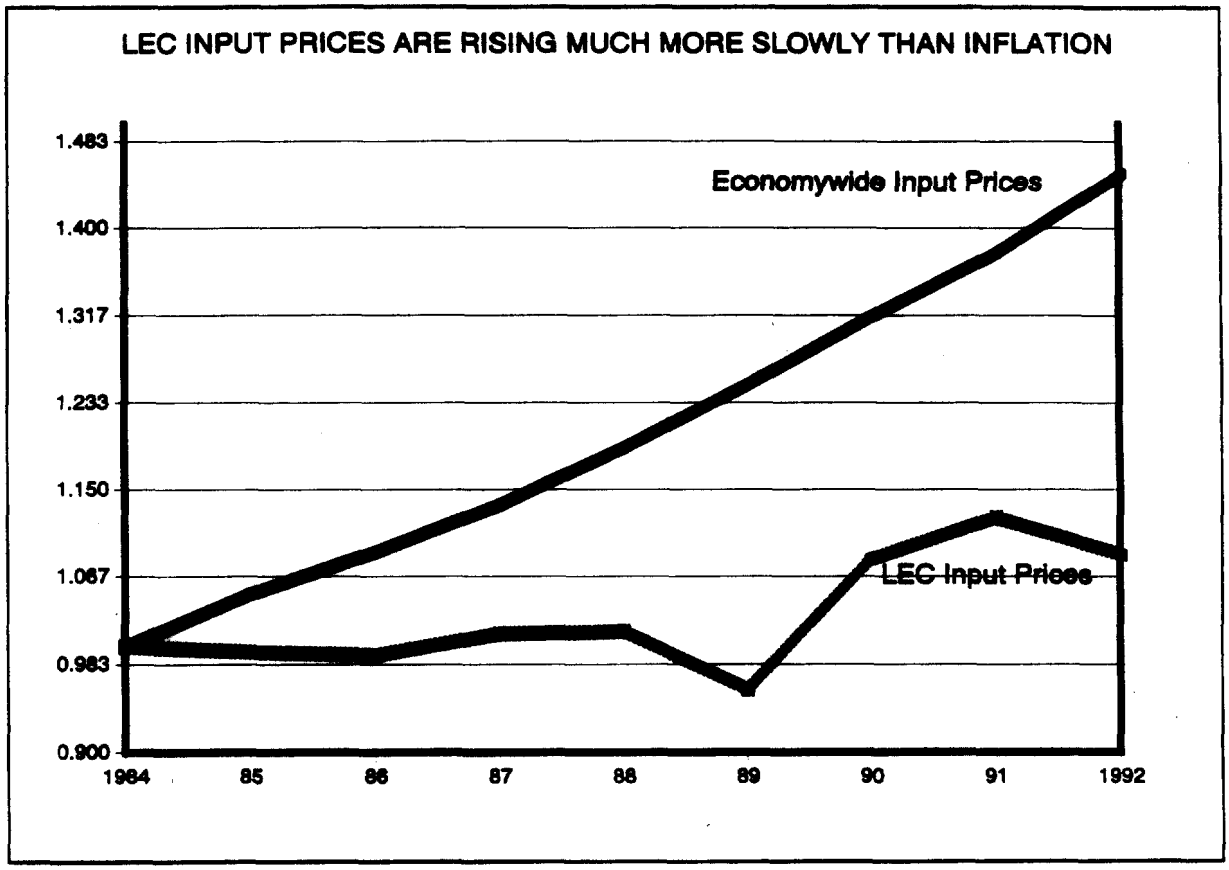

Figure 1

The Contrast Between Actual LEC Input Prices and the USTA's Assumption

As noted earlier, the actual historic input price differential should be used directly in the calculation of the price cap formula's X factor in order for the price adjustment mechanism to

25. Christensen Supplementary Data at Table 1. An excerpt of that Table is provided in Table 8 above. Note that the 8.8% is clearly shown in their table since the input price index increases from 1.000 in 1984 to 1.088 in 1992.